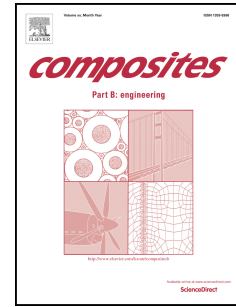


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Nonlinear Free and Forced Vibration Analyses of Axially Functionally Graded Euler-Bernoulli Beams with Non-Uniform Cross-Section

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Abstract

Nonlinear free and forced vibrations of axially functionally graded Euler-Bernoulli beams with non-uniform cross-section are investigated. The beam has immovable, namely clamped-clamped and pinned-pinned boundary conditions, which leads to midplane stretching in the course of vibrations. Nonlinearities occur in the system due to this stretching. Damping and forcing terms are included after nondimensionalization. The equations are solved approximately using perturbation method and mode shapes by differential quadrature method. In the linear order natural frequencies and mode shapes are computed. In the nonlinear order, some corrections arise to the linear problem; the effect of these nonlinear correction terms on natural frequency is examined and frequency –response curves are drawn to show the unstable regions. In order to confirm the validity, our results are compared with others available in literature.

Keywords: Functionally graded material Euler-Bernoulli beam, Nonlinear model, Vibration, Perturbation method, Differential quadrature method.

1. Introduction

Functionally Graded Materials (FGMs) are inhomogeneous composites made up of two different materials, generally a metal and a ceramic, with a smooth and predefined continuous variation of properties in axial (longitudinal) direction, transverse direction or occasionally in both directions. They were initially developed to remove the distinct interface

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